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Woodfuel Uses: A Distinct Phenomenon in Megacity Yangon, Myanmar

Zin Nwe Myint

Introduction

Before entering to 21st century, the idea of sustainable development had emerged through the increasing awareness of deteriorating environment. Tremendous efforts had been made to cure it by various actors in various sectors. Especially after the United Nations Conference on Human Environment known as First Earth Summit, held in 1972 at Stockholm, more attention to the concept of sustainable development was made. Later, it was realized that urban areas are suitable to put as focal points for considering sustainable development. The best highlighting fact of this is the growing urbanization with faster rates, especially in developing countries.

An important fact pointed out by Satterthwaite is that much of the sustainable development works almost exclusively concerned with the ecological point of view and little or no attention is put on development in the sense of meeting human need. In his approach to sustainable development, Satterthwaite made an important suggestion that the 'sustainable' part of sustainable development should be considered as avoiding the depletion of environmental capital while the 'development' part should be considered as the meeting of human needs (1997: 1680).

In developing countries, the demand of woodfuel by urban areas is often considered to be responsible for serious environmental degradation (FAO 1993: 91). In Myanmar, according to a report of the Central Statistical Organization (CSO), 60.73% of the total households of Yangon City used woodfuel in 1997. It seems that the same trend can be found until now.

In this situation, how can it be considered sustainable urban development of Yangon if the City is heavily relying on woodfuel? Because, on the one hand, woodfuel is extracted from the forests, destroying the environment and economically valuable resources, on the other hand, it is to fulfil the daily fuel need of the people in Yangon City.

This study aims at understanding the woodfuel utilization system in Yangon City, to assess the amount of woodfuel use according to sectors, to investigate the nature and extent of woodfuel marketing in Yangon City, to assess the impact of woodfuel uses, and to evaluate the woodfuel use of Yangon within the context of sustainable urban development.

Understanding the woodfuel system of Yangon can help towards the development of better energy planning and regulations that would allow to fulfil the energy need of Yangon in the most appropriate way and to lessen the undesirable impacts on supply sources. After all, it can effectively contribute to the sustainable urban development of Yangon City, by reducing the negative impact of woodfuel use both at the supply sources and in Yangon City and meeting the people's energy need.

In Yangon City the main woodfuel users can be grouped into two types, households and commercial businesses. Thus, the demand for woodfuel was studied through two surveys, focusing on household fuel uses and commercial business fuel uses. The main objectives of household and commercial business surveys are to know the fuel use pattern of households for cooking, to quantify the amount of woodfuel used by both household and commercial business sectors, to understand the nature of fuel choices, to understand the main reasons for choosing certain fuels, and to understand the perceptions of both households and businesses. Questionnaires for both types of surveys were distributed to all 33 townships of Yangon City. Besides, to understand the market situation of woodfuel in Yangon City, urban woodfuel trader surveys were made to acquire a broad understanding of how urban woodfuel trade is operating and to have some quantitative estimates of volume according to supply sources. Methodology used in this study was mainly qualitative, especially interviews were used.

Factors influencing the woodfuel uses in Yangon City

In Yangon City woodfuel is a major fuel for household cooking and no other mode of energy type can replace it until now. Thus, it becomes necessary to know why woodfuel is dominating as a main fuel in Yangon City.

Population Growth

As the population figures directly influence woodfuel use, the demographic situation of Yangon in the form of total population growth and household distributions is analyzed for a better understanding of woodfuel demand by Yangon City. The population of Yangon usually increases through many reasons: by natural increase, by migration and by boundary expansion. According to the 1983 census, Yangon had a population of 2,513,023. Since there were no censuses after 1983,

the estimated population data have been quite controversial. Data discrepancy always occurs between different institutional sources. The population of Yangon estimated by the Population Department was 4.11 million in 2003. An authority of YCDC said that it was nearly up to six million. Another source said that there were 5.47 million people in Yangon City in 1998 (Mi Mi Kyi et al. 2002: 542). By quoting a report to the State Peace and Development Committee, one scholar agreed with 5.47 million people in Yangon in 1999 (Yin May 2003). According to the surveys of Myanmar Marketing Research and Development Company, the population of Yangon in late 2002 was about 5.8 million.

Based on the data of the Population Department, figure 1 shows a clear picture on population growth of Yangon City in terms of households according to groups of townships.

According to figure 1, within thirty years, the number of households has more than doubled. If the Yangon City population is assumed at 5.8 million in 2003, the total number of households would be about 1.12 million. Such increase in households through population growth directly affects the energy demand. This has a pronounced effect on woodfuel use of Yangon through household cooking. Another significant change in figure 1 is the occurrence of new townships.

Group of Townships	Household Distribution			
	1973	1983	1993	2003
Main Business Area	36177	36055	41569	47588
Southern Townships	11270	13686	16617	22191
Inner Urban Townships	110260	118561	129374	151318
Outer Urban Townships	79298	97989	106681	129157
Older Townships	90545	112207	127457	170303
Northern Townships	62094	95499	101203	128346
New Townships	nil	nil	77828	148291
Total Yangon City	389644	473997	600729	797195

Fig. 1: Household distribution of Yangon from 1973 to 2003 (Source: Zin Nwe Myint 2004: 69)

Urban Expansion

One of the major determining factors of woodfuel demand is the expansion of the city. Figure 2 and 3 show the areal growth of Yangon.

At the end of the third Anglo-Myanmar War in 1885, the whole of Myanmar was under British Rule and Yangon became the capital city of colonial Myanmar. After Myanmar regained independence, Yangon continued to serve as the capital city. In 1959, under the Caretaker Government, three new satellite towns, South Ok-

Years	Area (Square Kilometres)
1901	72.52
1953	123.2
1965	165.57
1973	208.62
1983	346.12
1991	678.78

Fig. 2: Areal expansion of Yangon City (Source: Zin Nwe Myint 1998: 43)

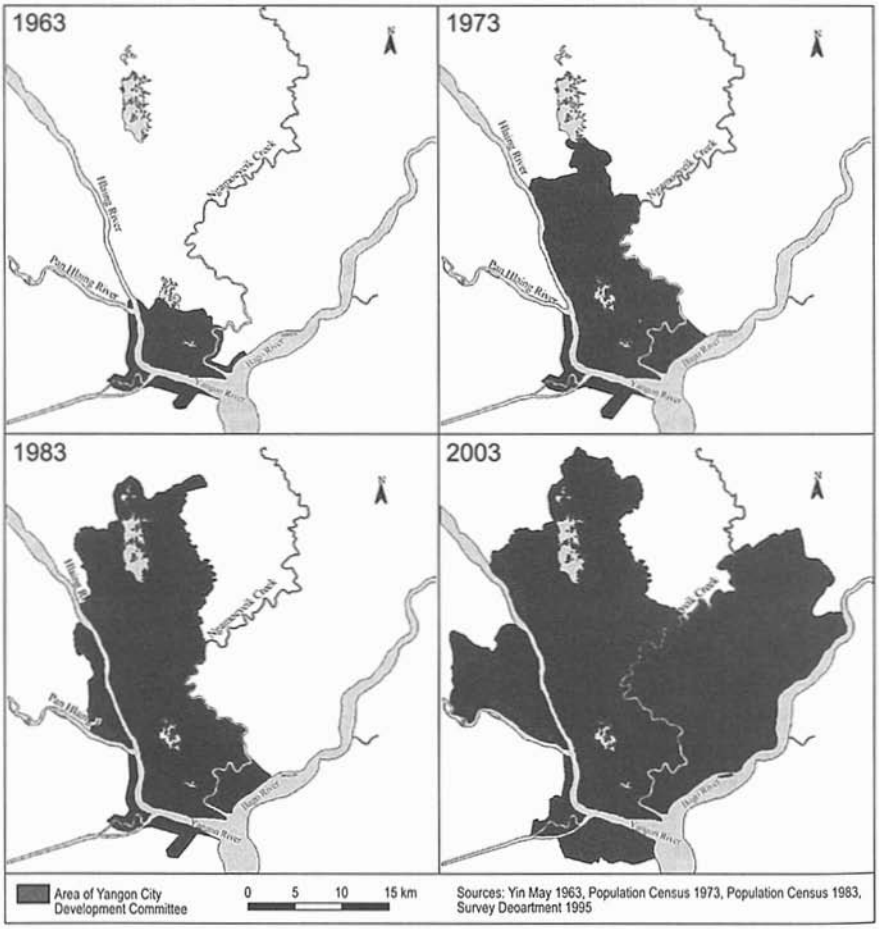

Fig. 3: Areal expansion of Yangon City

kalapa, North Okkalapa and Tharkayta were built. The Revolutionary Council had assumed power in 1962 and the city's area was extended to comprise 165.57 square kilometres. In 1974, the People's Council re-established the city area

again with 208.62 square kilometres. According to the 1983 census, Yangon City had 346.12 square kilometres. Soon after the political changes in 1988, Yangon City had largely outgrown this area due to the establishment of new towns, which are now new townships of Yangon.

The large New Towns are Dagon, Hlaingtharyar and Shwepyithar. Apart from these large New Towns, there are also many small New Towns such as Weibergi, Shwepaukkan, Pale and Padamyar. In 1995, the city area became 678.78 square kilometres, whereas the proposed area for Yangon City at that time was 793 square kilometres. This is the most influencing factor on woodfuel demand, as electricity and other alternative fuels cannot supply these areas sufficiently.

Another effect is the establishment of many industrial zones in new townships, which usually need large amounts of energy supply. Such large-scale industrial zones had never been established in Yangon City prior to 1988. The construction of industrial zones with the aim to help to develop these new towns is favourable. However, in the situation of insufficient electricity supply, these industrial zones use a considerable share of the total electricity supply of Yangon.

The electricity supply prior to the establishment of new towns was already insufficient. With insufficient supply of electricity, the normal supply was allocated to these industrial zones which consequently reduced the amount of electricity distributed to households. Thus, the establishment of New Towns is closely related to the use of woodfuel in Yangon, through increased insufficiency of electricity supply.

Insufficiency of energy supply

Although the population growth and urban expansion take place, if electricity and gas (LPG) can supply sufficiently, Yangon need not rely on woodfuel to such an extent. The main influencing factor on woodfuel demand of Yangon City is the insufficient supply of electricity and alternative energy.

According to data from Myanma Electric Power Enterprises (MEPE), the monthly electricity supply to all 33 townships of Yangon City was generally increased. Although the electricity supply had increased the gap between demand and supply is still great. Based on data from MEPE, figure 4 has been prepared to show the present electricity supply situation for domestic purposes to all townships of Yangon City for 1992, 1997 and 2002. In preparing this map, the monthly total electricity consumption of a household is assumed at a minimum of 185 kWh. It is calculated based on sample power consumption of essential electrical appliances for a household of Yangon City. This calculation is interpreted with a map which shows that many townships, especially new townships, did not have this minimum requirement of electricity in 1992, through 1997 and until 2002.

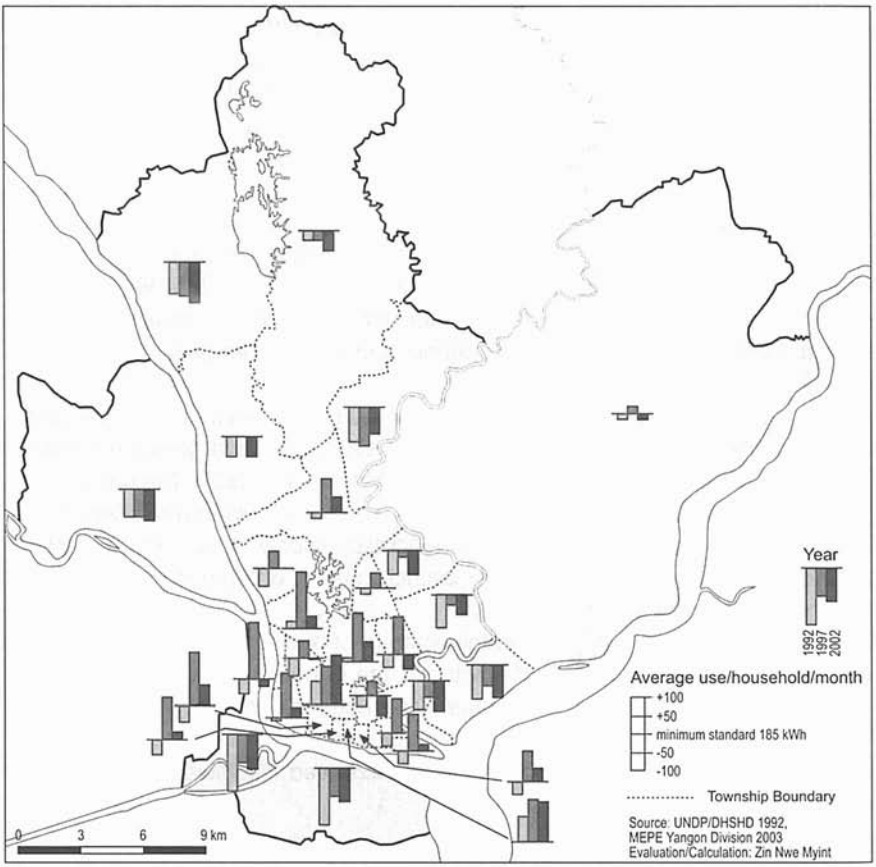

Fig. 4: Domestic electricity consumption in townships of Yangon City for 1992, 1997, 2002

Another suitable fuel type for cooking in Yangon City is gas (Liquefied Petroleum Gas/LPG) which is mainly controlled by the State. Although the amount of LPG use is increasing, the total number of LPG gas stoves permitted by Myanma Petrochemical Enterprise (MPE) was far lower than the demand. From December 1988 to January 2003, the permitted amount of LPG cylinders for household cooking was a total of 26,622 for the whole country (MPE: 2003). Even if all these were assumed to be distributed for Yangon City, this can only support about 1/45 of the total households of the City, if the Yangon City population is assumed as 5.8 million in 2003.

In Yangon City, the increase of population and urban expansion are influencing factors of woodfuel use. Above all, it is the insufficient energy supply, especially electricity. It is severely insufficient due to many difficulties, such as technology, investments, especially of foreign investments, etc. which all are acting upon the

State's policy and performance of the related institutions. Apart from electricity, natural gas is not widely used for cooking as the supply is very limited although a large potential exists and is produced in Myanmar. Thus, in such a situation the basic need of energy in Yangon City is met by woodfuel, especially charcoal.

Woodfuel Demand of Yangon City

Woodfuel use in the household sector

From the household fuel use survey, it was discovered that the average amount of charcoal used for cooking per household is 0.82 kg per day (0.5 viss in Myanmar traditional measure), regardless of household size and income situation (own survey 2003). The annual consumption of charcoal per household is 293.93 kg or 0.3 metric tons per year. According to calculations based on the total population of 5.8 million in 2003 and 60% of the total households using charcoal for cooking, the estimated amount of annual charcoal demand by residential sectors of Yangon will be about 202,325 metric tons per year.

According to figure 5, charcoal is used in all household expenditure categories. The highest use is found especially in the lowest expenditure group with 65% of the total households having an expenditure of under Kyats 30,000 (1 US$ was about 900 Kyats in 2003). In these per month household expenditure groups, the percentage use of charcoal is markedly reduced while the use of electricity

Fuel Type	Household Expenditure Categories (Kyats/Month)											
	0-30000		30001-60000		60001-90000		90001-120000		120001-150000		Above 150000	
	n	%	n	%	n	%	n	%	n	%	n	%
Charcoal	41	65	90	58	31	62	15	41	3	38	5	29
Firewood	2	3	4	3	0	0	0	0	0	0	0	0
Electricity	20	32	54	35	12	24	15	41	1	13	6	35
LPG	0	0	7	5	7	14	7	19	4	50	6	35
Total	**63**	**100**	**155**	**100**	**50**	**100**	**37**	**100**	**8**	**100**	**17**	**100**

Fig. 5: Primary cooking fuel according to household expenditure category of Yangon City in 2003 (Source: Own Household Fuel Use Survey, 2003, Note: n = number of sample households)

and LPG has increased. The highest LPG use, 50% of the total households, was found in the monthly expenditure category of between Kyats 120,000 and 150,000. Thus, it may be concluded that the ability to spend a high household expenditure exerts a strong influence on the main fuel type for cooking in Yangon City.

Of the charcoal using households, 72.43% of the total respondents were very pleased to use it as their main cooking fuel. The three main reasons are: it can be used anytime, it is safer to use than other fuels and its easy availability. By this, the main reason for using charcoal is because of the easy availability of it and due to problems in the use of electricity.

According to the survey, 65.15% keep another type of fuel apart from their main fuel. This clearly expressed that only limited households (37.7%) can rely on one type of fuel for cooking purposes. It indirectly shows that the availability of commercial energy types even to use as secondary fuel is limited. Figure 6 shows that woodfuel is essential in all combination patterns of fuel uses. According to this table, the combination of charcoal and electricity is most frequently found (62.3%). As such, the lesser the reliance on electricity the greater is the use of charcoal.

Fuel combination pattern	% to total sample households
Charcoal and electricity	62.3
Electricity and LPG	16.7
Charcoal and LPG	9.8
Charcoal and firewood	7.9
Firewood and electricity	0.5
Other combination	2.8

Fig. 6: Major fuel use combination pattern in households of Yangon (Source: Own Household Fuel Use Survey 2003)

Concerning the availability of woodfuel in future, 72.43% of the total respondents using charcoal answered that it will still be available for the next five years in the same way as now. Nearly 60% thought that charcoal will still be available in the next ten years with higher prise. This clearly shows that a larger proportion of respondents usually feel that charcoal will be available in future. Such perception always causes the respondents to rely on charcoal rather than on other fuels for cooking as electricity and gas are in very limited supply.

Concerning the perceptions on health, 64.3% of the total felt that it is not harmful, whereas 22.7% felt that it is harmful to health. The rest of the households answered that they had never considered this before. As a larger proportion of respondents do not feel that it is harmful to health and as it has been traditionally used, people usually think charcoal is good for cooking. This perception has also enhanced the use of charcoal in Yangon City.

When the perception on the most suitable fuel for household cooking in Yangon City was asked, more than 54% of the total respondents suggested electricity and 25% suggested charcoal. Only 18% suggested gas. The rest of 3% suggest others. The preference for charcoal to gas is mainly because of safety reasons.

Concerning firewood, 1.8% of the total sample households use it in Yangon City. Approximately 75% of the firewood-using households cook twice a day. Out of the total firewood using households, about 50% have used firewood for more than 10 years. The main reason is because of its cheapness, answered by 43% of the total. The second reason is the easy availability, answered by 29%. The daily average cooking time using firewood is 3.5 hours.

Concerning the perceptions of firewood users, 75% of the respondents think that firewood will be still available in the next ten years. Concerning health, about 50% of the households answered that they had never considered it. Approximately, 25% of the respondents felt that it is harmful to health and the rest think that it is of no harm to health.

Woodfuel Use in the Commercial Sector

As commercial businesses vary in types and sizes, these are grouped into three broad categories as teashops (cafés), restaurants and others. The 'others' include various types of food service businesses apart from teashops and restaurants, e.g. *mont-hin-kha*, Shan noodle, etc.

Based on an own commercial business fuel use survey, nearly 81% of the total commercial businesses of various sizes use charcoal as their main fuel type. Firewood is used by 0.6%, gas by 6.7% and briquette by 12% of the total samples. The average use of charcoal by a teashop was 34 kg/day, by a restaurant 36 kg/day. The 'others' type of businesses, which are mostly Myanmar traditional fast food shops, use 24.5 kg of charcoal per day per shop on average (own Survey 2003).

There were 3766 teashops and 2323 restaurants of various sizes registered at Yangon City Development Committee (YCDC) during 2002. Based on this and survey results, the total consumption of charcoal by all these commercial businesses was about 6741 metric tons per month, making a total of 80892 metric tons per year. This was only based on the registered commercial business establishments of YCDC. The most important reason for using charcoal, answered by 31.4% of the total respondents, is the easy availability. The second is the suitability of charcoal for their business, answered by 15.2%. The third reason is traditional use with 14.3% and safety with another 14.3%.

Concerning the perception of commercial business owners, 79% of the total wished to mostly use charcoal. The second was gas (LPG) which was answered by 12.8% of the charcoal using respondents. The main reason for preferring gas is its capacity for fast cooking. Electricity and briquette are each answered by 3% of the total. This means that the preference of electricity is less than that of charcoal (own Survey 2003).

In newly established townships, cafés, restaurants and eateries usually use firewood as main fuel. About 80% of the fuel need is met by firewood and the remaining 20% is fulfilled by charcoal. The main reason for using firewood is because it can cook quickly partly because of traditional use. The price of firewood is Kyats 40 for 5 kg of firewood. A small restaurant uses to pay Kyats 12,000 per month for firewood. It is difficult to have an exact measure for firewood.

The questionnaire survey of commercial businesses is made for well-established business in all 33 townships of Yangon. Apart from these, there are many unregistered food related businesses using woodfuel. Among these, the major woodfuel users are the roadside food vendors, most of whom are concentrated in the downtown area of Yangon City. For this category, a separate survey was made on five main east-west roads in downtown. According to this survey, the total number of roadside eateries which use charcoal on these main roads was 812. Based on the amount of charcoal, 171 (21%) are assumed as large users, 374 (46%) are medium and the remaining 267 (33%) are small users. The calculation was based on 11.4 kg (7 viss) of charcoal per day for large users, 6.6 kg (4 viss) for medium users and 3.3 kg (2 viss) for small users. Their total charcoal consumption was 5.1 metric tons (3119 viss) per day making a monthly amount of 153 metric tons (93,570 viss) during January 2004. The actual amount can be far greater than this, because the survey was done only for five major roads whereas there are numerous roadside food vendors in many crossroads.

It is difficult to obtain the amount of firewood consumption by roadside food vendors. Some use waste-wood from construction sites while others use branches of trees that they have collected. Some food vendors answered in terms of money that they had paid for firewood and the actual amount of firewood cannot be assessed as the price varies. Thus, a proper estimation of firewood used by roadside food vendors on the main five east-west roads of downtown area cannot be made properly.

It may be concluded that the commercial businesses prefer woodfuel because it is always easily available, safe to use in their perception, cheap, time-saving and easy to handle. Though briquettes made by coal and petroleum coke can be replaced at low cost, stoves for these fuels are considerably expensive and pots and pans are damaged frequently because of intense heat which is not convenient and wasteful to control. Apart from it, briquettes are limited due to insufficient

production. Thus, at present charcoal is essential for larger portions of commercial businesses in Yangon City. This situation is expected to be the same in the foreseeable future.

Other Uses

Apart from households and commercial business activities, woodfuel is used in various amounts in various types of businesses like bakeries, dyeing businesses, noodle making, melting of wax, making of soaps, mosquito coils, aluminium pots and pans, and in batteries works. Although it is used in many ways in Yangon City, statistics of these business activities according to types are limited. Besides, some institutions, like monasteries, are major users of woodfuel, especially firewood whereby it is difficult to know the actual amount of use.

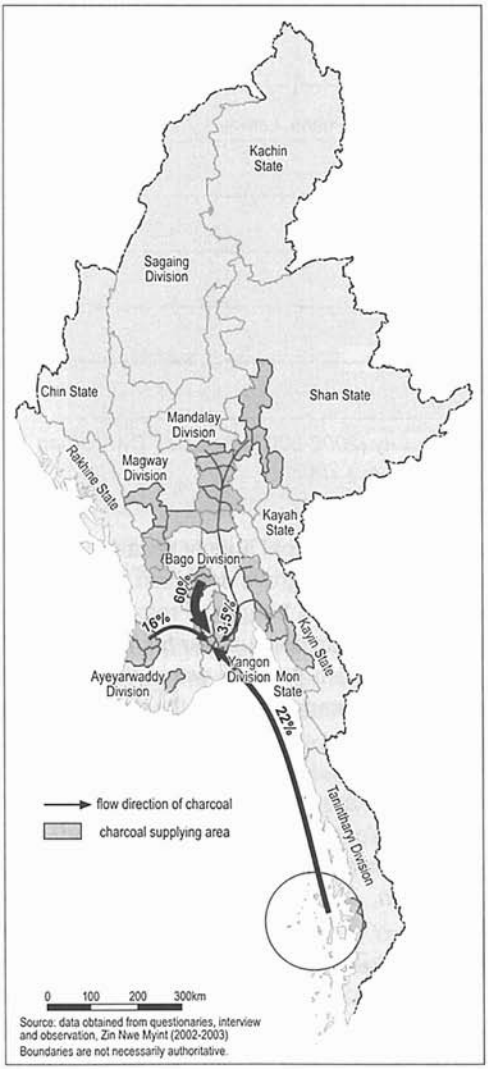

Fig. 7: Major charcoal supply areas and direction of flows to Yangon City 2003

Woodfuel Supply for Yangon City

The main supply sources of woodfuel in Myanmar are natural forests, local supply plantations, roadsides and perimeter plantations and tops and lop from logged-over natural forests. Traditional and the most important sources of woodfuel are the natural forests.

Supply sources and woodfuel flows to Yangon

The supply sources of Yangon City are not known exactly because it is transported from various

places of Myanmar and the whole system is thriving illegally. Though the actual amount is not known, the percentage share of sending charcoal from the main supply sources to Yangon City according to States and Divisions is shown in figure 7 and 8.

	Major supporting towns according to State and Division
1	**Ayeyarwady Division (14%)** Kyangin, Pathein, Thabaung, Myaungmya, Mawlamyingyun
2	**Bago Division (57%)** Paukkhaung, Pandaung, Htonbo, Gyobinkauk, Oakpho, Minhla, Yetasha,l Taungoo, Oaktwin, Phyu, Kyaukgyi, Shwekyin, Madauk, Bago
3	**Magway Division (3%)** Aunglan, Thayet, Kanma
4	**Mandalay Division (1%)** Tharzi, Pyawbwal, Yamethin, Tatkone, Pyinmana, Lalway
5	**Tanintharyi Division (22%)** Myeik (Kyunsu)
6	**Yangon Division (0.5%)** Taikgyi, Hmawbi, Hlegu
7	**Kayin State (0.5%)** Phaan
8	**Mon State (1%)** Bilin, Kyaikhto
9	**Shan State (1%)** Yatsauk, Taunggyi, Kalaw, Sesai

Fig. 8: Main woodfuel supply areas to Yangon City (2002-2003) (Source: Own Urban Woodfuel Trader Survey 2003, and interviews 2003)

Until 1993, *Ayeyarwady* Division was the main charcoal supply area for Yangon City. It was strictly banned in 1993 due to severe mangrove depletion. Since then, woodfuel has been imported from various places to Yangon. From that time to early 2004, *Bago* Division became the largest charcoal supplier for Yangon City. This was due to the implementation of many dam projects within the Division. Constructions of dams are the only areas that clearly clean all the natural vegetation from which charcoal can be produced.

The major charcoal transport routes to Yangon are:

(1) From *Gyopinkauk, Oakpho* through Yangon-Pyay-Mandalay Road,
(2) From *Padaung, Htonbo, Kyangin* by waterway,
(3) From *Pyinmana, Lalway, Shwekyin, Madauk, Bago* through Yangon-Bago-Mandalay Road, and
(4) From *Myeik* by waterway (Interviews 2003).

Large ships and boats which carry charcoal from the *Kyangin* area and *Myeik* usually discharge their load at Yangon Port and *Chaungwa* jetty in *Kamayut* Town-

ship. From these jetties, it is most convenient for charcoal bags to be transported straight to woodfuel shops within Yangon City by lorries of various sizes. Transport charges are mainly dependent on the current prices of petroleum, diesel oil and engine oil, and the distance to the woodfuel shop. The amount of charcoal brought to Yangon is highest in March and April. Figure 9 is a simplified diagram of charcoal flow to Yangon from various places.

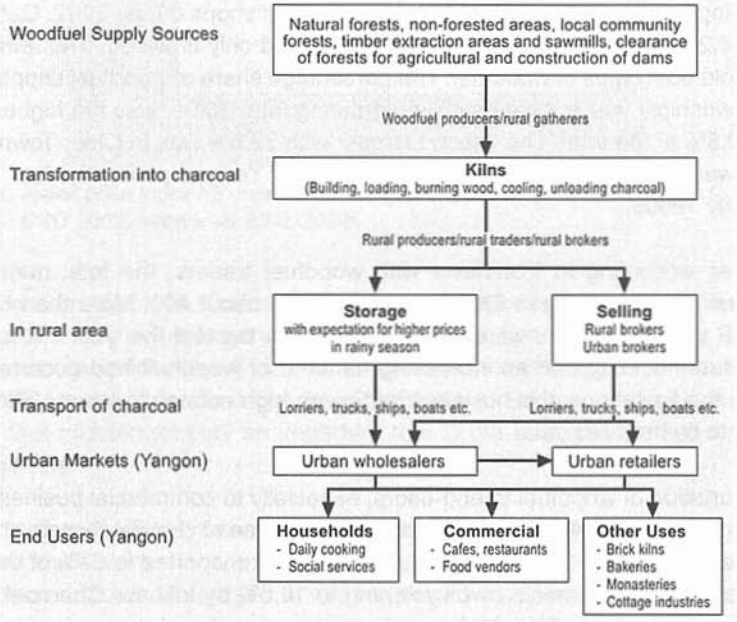

Fig. 9: Simplified model of charcoal flow to Yangon City (Source: Own draft based on observation and interviews 2002-2003)

The major supplying sources of firewood for Yangon City are village tracts of Mandalay, Magway and Bago divisions. Wood wasted from sawmills, especially from large state-owned sawmills and private sawmills is usually used as firewood. The main supplies of firewood for Yangon City are from these areas where large sawmills exist. Approximately 50% of the total amount of firewood brought to Yangon City is from *Phyu*, *Zayyawaddy*, *Swa* and *Oaktwi*n, with sources in the eastern Bago Range. The remaining 50% is from *Oakshippin* and *Pyay*, along with sources in the western Bago Range.

Firewood is usually transported to Yangon by railway, lorries and trucks. A larger proportion of the firewood is transported by rail. The main distribution points of firewood functioning as wholesale centres within Yangon City are found at Thingangyun railway station and in Ywama Ward of Insein Township. From these two places, firewood is distributed to all other wholesale and retail shops of the City.

Within Yangon City area, Thingangyun railway station has enough space for the shunting of rail wagons and the unloading of firewood. Thus, the large wholesale shops of firewood are found just beside the railroad close to the Thingangyun railway station.

Distribution of woodfuel within Yangon City

According to YCDC, there were only 295 woodfuel shops during 2002. Out of the total, 74.2% were charcoal shops and 20.6% sold only firewood. The remaining 5.2% sold both types of woodfuel. The percentage share of woodfuel shops in the new townships, which were established during late 1980s, was the highest, having 30.5% of the total. The second largest with 22.5% was in Older Townships, which were developed as new satellite towns of Yangon during the late 1950s and early 1960s.

However, according to interviews with woodfuel traders, the total number of woodfuel shops in Yangon City during 2004 was about 400. More than 50% of the total woodfuel shops were established within the last five years. It may be concluded indirectly that an increasing demand of woodfuel had occurred and despite the limitations, this business had given high economic returns attracting people to be involved more.

Transportation of woodfuel to end-users, especially to commercial businesses is usually undertaken by the woodfuel shop owners free of charge. Bicycle and trishaw are mainly used for transporting. Charcoal is transported to 67% of the total commercial establishments by bicycle and to 16.5% by trishaw. Charcoal transport by cars was only 7% of the commercial business and the remaining 9.5% was by pushcarts (own survey 2003). There is a well-established distribution system of woodfuel to end-users. This plays a significant role for easy availability of woodfuel in Yangon City.

Woodfuel prices in Yangon City

According to interviews, there is a variation in charcoal prices in Yangon depending upon the quality of charcoal, the distance from supply sources, and the mode of transport. During 2002-2003, the retail price for 1.64 kg (one viss) of charcoal was Kyats 160 on average, irrespective of size and quality. Figure 10 clearly illustrates the increase of charcoal prices in increasing rates. Charcoal prices also depend on how the shop owners get it for reselling. In Yangon City, 67% of the total woodfuel shop owners order charcoal through middlemen. About 23% of the total wholesale and retail shops get charcoal from large wholesale shops. Only a few shops, about 10% of the total charcoal shops, can directly order from rural producers. This poses a great risk for the businessmen since the cash is given in advance to rural producers. On the other hand, it has an advantage as

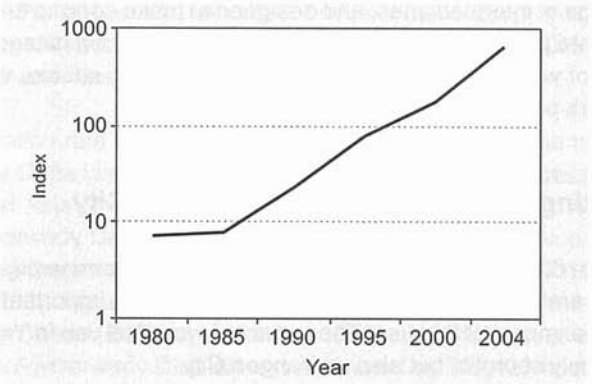

Fig. 10: Retail price index for charcoal in Yangon City (Base year 1997 = 100) (Source: CSO 2002, Interviews 2002-2004)

charcoal can be sold at a comparatively cheaper price because it has no cost for middlemen. Only a few large wholesale shops can operate in this way. The rate of payment to middlemen, 6 or 7 Kyats per one viss (1.6 kg) of charcoal during 2003-2004, contributes to a considerable share in end users' prices. It can be learnt that middlemen play an important role in the woodfuel market system of Yangon City.

Apart from these facts, there is an occasional rise of charcoal prices due to increased inspections of the Forest Department at the production areas as well as on transport routes. This used to happen once within two or three years. If this takes place in some supply areas, more charcoal from other sources was brought in to meet the demand of Yangon except with a rise in charcoal prices. The minor reasons are difficulties in transportation due to climatic situations, lack of oil or diesel and less production of charcoal at supply sources.

Perceptions of woodfuel businessmen

The perceptions of businessmen play an important role in the future woodfuel business of Yangon. More than 72% of the woodfuel businessmen perceive that electricity supply and natural gas cannot be sufficient in the near future and thus woodfuel cannot be replaced by any other energy type in Yangon. This indirectly means that most of the woodfuel shop owners wish to continue their business and 75% of them have a firm belief that the business would be economically beneficial in the near future. Even if gas and electricity can be supplied, 72% believe that the woodfuel business in Yangon City cannot disappear (own survey 2003).

In Yangon City, it appears that there are a number of different woodfuel markets, selling woodfuel, especially charcoal, in varying quantities, shapes and forms,

involving a range of intermediaries, and designed to make specific fuels available at the appropriate prices and quantities demanded by different categories of end-users. Supply of woodfuel is mainly dependent on trading source, where urban woodfuel traders play an important role.

Impact relating to woodfuel uses of Yangon City

Since more than 60% of the total households and 81% of commercial businesses in Yangon City are heavily relying on woodfuel, it becomes important and necessary to know the impact of this use. The impact of woodfuel use in Yangon City is not only on supply sources, but also on Yangon City.

Impact on Supply Sources

In the ecological nature, the most critical and direct impact of woodfuel use beyond the production capacity is loss or degradation of the natural vegetation. The consequence of this is the socio-economic stress imposed on the poorer population. Figure 11 clearly shows the decline of actual forest area of Myanmar.

According to figure 11, it is obvious that the actual forest cover has diminished by nearly 20% within 50 years. The loss of closed forest is most crucial and the trend clearly shows an increase in deforestation (Forest Department 1999: 9). According to an interview with an officer of the Forest Department, at least more than 50% of deforestation in Myanmar is mainly the result of woodfuel production. Concerning the environmental deterioration in supply sources due to woodfuel

Year	Land cover type (sq. km)		Percentage to total land area		
	Actual Forest	Others	Actual Forest	Others	Total percentage
1955	385635.2	290917.8	57	43	100
1975	323216	353337	47.8	43	100
1989	292579	38974	43.2	46.2	100
1997	252939	423614	37.4	62.6	100
2005	173738.8	502814.2	25.68	74.32	100

Fig. 11: Actual forest area of Myanmar (Source: Maung Maung Than 2001: 2-5 and interviews 2004-2005)
Note: The total land area of Myanmar is 676,553 sq. kilometres.
The actual forest means closed forests, where trees in various stories and the undergrowth cover a high proportion (with over 40%) of the ground and do not have a continuous dense grass layer. 'Others' means all other type of land apart from the closed forest areas, which include many forms of degraded forests and other wooded lands and all the other lands, such as agricultural land and settlement areas.

extraction, 63% of the total woodfuel businessmen accept that environmental degradation really occurred in rural supply areas due to over-cutting of trees (own survey 2003 and interviews 2003).

The degradation rate is more serious in mangrove forests. The mangrove of the Ayeyarwady Delta is one of the most extensive contiguous areas of mangroves in Southeast Asia and it used to be one of the most diverse in species in the world. Ayeyarwady Delta had served as the sole supplier of woodfuel for the rapidly growing Capital City of Yangon for a long time up to 1993 (Heymann/Löffler 1997: 291-292). Figure 12 clearly indicates the reduction of mangrove forest of Ayeyarwady Division between 1924 and 1995. In 1924, the total area of mangrove forests in Ayeyarwady Division was estimated as 253,423 hectares. Within 71 years, only 12.3% of the existing mangrove area of 1924 was left in 1995.

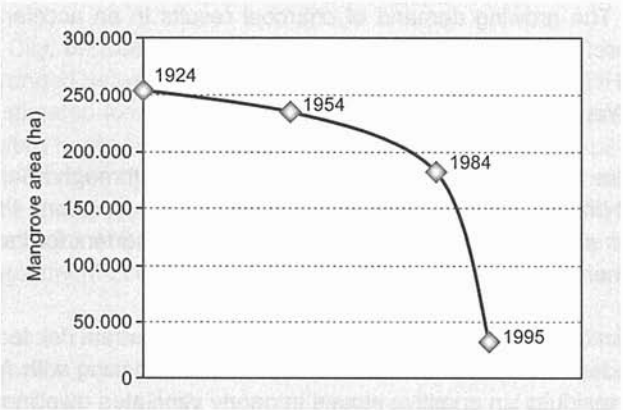

Fig. 12: The decline of mangrove area within Ayeyarwady Division during 1924 and 1995 (Source: Kyaw Soe Win 1999: 7)

Among many causes of mangrove depletion, extraction of woodfuel was the main reason especially before 1993 (Heymann/Löffler 1997: 292, Aung Kyaw Sint 1998, Htin Aung Kyaw 2003: 75) and it has a direct severe impact on the mangrove ecosystem of Ayeyarwady Delta. Ohn expressed the main reason of mangrove depletion in Ayeyarwady Delta as: "In fact, the growing Yangon City urban fuelwood and charcoal demand is mainly responsible for the depletion of Ayeyarwady mangroves apart from their conversion to agricultural area" (1992: 23).

The consequences of mangrove forest depletion were not just scarcity of woodfuel supply or local supply of other mangrove forest resources. Depletion of mangrove forests means depletion of these resources leading to substantial socio-economic losses.

A clear message was given by Fielding as: "Tourism experts are more worried about the effect of deforestation on the natural beauty and wildlife diversity of coastal areas. Fewer mangrove forests mean fewer dolphins, fewer crocodiles, and fewer birds. Fewer animals mean fewer ecotourists" (2002: 7). Thus, the mangrove ecosystem has a strong impact not simply on the socio-economic situation of both rural and urban communities of the region but also on national income through tourism .

While the utilization of woodfuel is increasing, the supply becomes more deficient in many areas. The greater the extent of scarcity the higher the price rise, which is especially true for Yangon City. The demand of woodfuel will rise in association with growing population and growing urbanization. Usually, the price will rise if the demand is not met. If the demand is met (mostly through illegal practices), severe ecological and socio-economic effects will be the result due to rapid deforestation. The growing demand of charcoal results in an accelerated rate of deforestation. The situation thus describes the dilemma.

Impact on Yangon City

Woodfuel use also has an impact on Yangon City itself through health problems and fire out-breaks. Although woodfuel has been used for a long time, there is little concern about its impact on Yangon City. Most important for the population is to solve their daily fuel need.

Studies indicate that exposure to wood smoke is an important risk factor in pneumonia (Pandey 1997: 3-5). Indoor air pollution from cooking with fuel wood or agricultural residues on primitive stoves in poorly ventilated dwellings is a major cause of respiratory ailments, illnesses, eye problems, especially for women and children. One main reason for this is burning firewood and charcoal using traditional ways both for domestic needs and for energy generation in small businesses (Farinelli 1999: 5). Women usually inhale smoke, including toxic gases emitted from these stoves. Exposure to carcinogens in emissions from biomass fuel combustion has been confirmed in studies and women who may spend 2 to 4 hours a day at the stove must be at risk to all these diseases (Hardoy et al. 1992: 48).

Although there is no research concerning this aspect in Yangon City, according to an own survey, approximately 79% of the total sample households have a cooking time of more than two hours daily. From this, it may be assumed that these woodfuel using households have some health problems relating to cooking fuel. However, in Yangon City the problem of indoor smoke pollution has been given almost no attention.

Another important impact of woodfuel use on Yangon City is fire outbreaks. According to figure 13, the percentage of occurrences in Yangon City in comparison

Years	Myanmar	Yangon	% of Yangon City to total Myanmar
1985	1255	201	16
1990	1519	307	20
1991	1815	447	25
2000	876	203	23
2001	868	197	23

Fig. 13: Occurrences of fire in Myanmar and in Yangon City (Source: Zin Nwe Myaint 2004: 142)

to the whole of Myanmar had increased from 16% in 1985 to 23% in 2001. The trend shows that more than 20% of the fire outbreaks in Myanmar occur in Yangon City. The cooking stoves were responsible for 22%, 17% and 12% of the total fire outbreaks of Yangon City in the years 2000, 2001 and 2002 respectively.

In Yangon City, between 1985 and 1991, the yearly estimated loss due to fire outbreaks ranged between Kyats 3 million and 95 million (UNDP/DHSHD 1992b: 39). The estimated losses for the whole country due to fire outbreaks in 1985 and 1990 were Kyats 166.22 million and Kyats 320.62 million respectively (CSO 2002: 406). The loss by fires in Myanmar rose to Kyats 4830.39 million in 2001. Although the amount of loss cannot be estimated for Yangon City in monetary terms, there were 688 fire victims who lost houses and property in 2001 (Fire Service Department 2003).

Woodfuel use in Yangon City is a fundamental need in the daily life of the people, and its extraction from the natural environment causes a great loss in both environment and socio-economic aspects. However, the trend of the energy supply situation is likely to be the same in the near future. Thus, concerning woodfuel utilization and sustainable urban development of Yangon City, at present it is on the tract of a vicious cycle.

Strategies for sustainable urban development and woodfuel use in Yangon City

In Yangon City, households are the largest woodfuel consumers in terms of consumption. The commercial businesses are the second largest users. Collectively, Yangon City needs at least 285,000 metric tons of charcoal per year. Requirement of firewood for all types of uses in Yangon is about 53,000 metric tons per year. In fact, it can be much more than this amount. Besides, investigations into the use of woodfuel by cottage industries are still needed. In an assessment of the sustainable urban development of Yangon City, figure 14 illustrates the present situation of woodfuel uses in Yangon City. The advantages and disadvantages according to three basic aspects of sustainable development are recognized.

Basic Aspects of Sustainability	Advantages	Disadvantages
Social Aspect	- Daily basic need for cooking - Easily available any time - Affordable cost - Traditional use - Sufficient supply - Easy to handle - Low or no cost for stove	- Indoor air pollution - Health effects - Time consuming to cook with - Bothersome to use - Burden on women through having less time for other work, education, etc. - No/less recognition in energy planning - No proper data and information
Economic Aspect	- Generate income for both rural and urban people - Employment opportunities - More economic for use in business - Low cost for stoves - Most suitable fuel type for commercial business - Save foreign exchange currency through less import of commercial fuel	- Indirect effect on eco-tourism - Loss of income - Endanger the livelihood of rural people in supply areas - Costly and time consuming to recover the environmental damaged caused by over cutting of trees
Environmental Aspect	- Renewable energy - Net emission of carbondioxide is zero if re-growth is sufficient - Heat intensity of charcoal is not low as compared with others - Can be produced in sustainable way	- Forest depletion and degradation - Loss of biodiversity - Consequences of forest depletion, soil erosion, watershed degradation, etc. - More carbondioxide to atmosphere due to reduced absorption power of trees - Becoming a larger footprint

Fig. 14: Woodfuel uses of Yangon City in sustainable urban development context

Sustainable urban development of Yangon City regarding the use of woodfuel is to lessen the disadvantages and increase the advantages. For this, the most important is to understand the present overall energy situation of Yangon City and woodfuel use. The basic need is the institutional commitment to recognize woodfuel as an effective energy type and to adopt a sustainable wood energy development mechanism before other commercial energy types can be sufficiently supplied for Yangon City. It is the question of how policy, technology and education programmes can effectively work together in approaching sustainable urban development of Yangon City.

Strategies that should be immediately performed for achieving sustainable energy development of Yangon City to enhance sustainable urban development are:

- To distribute improved, efficient stoves directly to households at the lowest possible price,
- To improve the quality of briquettes so as to attract the users,

- To make briquettes easily available at a sufficiently low price,
- To levy 'environmental tax' to woodfuel shops of Yangon City according to their size,
  [If environmental tax is levied to woodfuel shops in Yangon City, firewood and charcoal prices can become higher. Nevertheless, if it does happen, people will turn to quality briquette, which can be used at low prices. Most important is to make sure that briquettes are easily available like charcoal and firewood.]
- To adopt effective laws and regulations for woodfuel markets to thrive properly in Yangon City,
- To create a policy environment to integrate wood energy in the overall energy planning for Yangon City,
- To organize a working group to construct an energy database which is a prerequisite for planning and management,
- To build indigenous human capacity to develop technologies, research and planning,
- To undertake continuous research on woodfuel demand and supply for Yangon City so as to regulate the changes in market situation and supply, which is necessary for energy planning,
- To adopt "leapfrogging" technologies, from unsustainable technologies directly to newer and more sustainable approaches,
- To make effective educative programmes for using woodfuel efficiently through improved stoves,
- To adopt integrated energy planning incorporating wood energy for Yangon City as soon as possible,
- To increase the LPG supply to the public without restrictions at a rational price.

Paramount to these strategies is the concept of "leapfrogging" to new technologies and integrating woodfuel in the overall energy planning for Yangon City. Despite the need for adaptation, such new technologies and institutional arrangements will offer the best hope for Yangon City to move towards sustainable development. At present, sustainable urban development of Yangon City which relies on woodfuel is to minimize the negative impacts of woodfuel extraction from the natural environment, while at the same time, ensuring the people's need of woodfuel through systematic production and efficient use without any waste.

Conclusion

Woodfuel is a basic need for two billion people in the Asia-Pacific region and accounts for 70% to 80% of the total round wood harvest. Despite this, wood energy is still largely considered as traditional fuel in many countries.

In Yangon City, more than 60% of the total households and more than 80% of the total commercial businesses like teashops, restaurants and various food vendors rely on woodfuel. Generally, the main reasons of woodfuel use in Yangon City are population growth, urban expansion, and the failure for sufficient supply of commercial energy. It is expected that there will not be much change in the fuel consumption pattern in Myanmar as well as in Yangon City in the near future.

To meet such daily needs of Yangon City, woodfuel is transported from various supply sources, which is mainly from natural forests. At present, forest depletion and degradation is in an alarming situation. It is believed that about 50% of this depletion is related to woodfuel extraction. As woodfuel is used by the majority of the people, the supply of woodfuel to Yangon City is an unavoidable task. However, the way of fulfilling woodfuel need has negative effects on both the socio-economic and the natural environment of the supply sources. Since capital and foreign exchange are scarce, the ability to pay for imported fuels and technologies as well as investments are limited according to the economic situation of Myanmar. Thus, until alternative energy types can be supplied sufficiently, seeking the ways to lessen these negative effects by using woodfuel is the sustainable urban development of Yangon City.

Though a comprehensive view on the woodfuel utilization system of Yangon City can be gained, due to many limitations the sample size used in this study is arbitrary for generalization of the whole city. Much research work is needed to investigate the impact of woodfuel use in both Yangon City and supply sources. A systematic survey should be conducted to get timely and reliable data and to disseminate information on true events and situations to integrate wood energy in the energy planning for Yangon City towards sustainable urban development.

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